In the Specification

Kindly replace [paragraph 0001] with the following:

Technical Field

~~The present invention~~ This disclosure provides a high-strength steel sheet useful for applications to automobile steel sheets and the like and having excellent deep drawability, a high tensile strength (TS) of 440 MPa or more, and a high r value (average r value ≥ 1.2), and also provides a process for producing the same.

Kindly replace [paragraph 0006] with the following:

As means for increasing strength while maintaining a high r value, Ti and Nb are added in amounts sufficient to fix carbon and nitrogen dissolved in ultra low carbon steel to form IF (Interstitial atom free) steel to be used as a base, and solid-solution strengthening elements such as Si, Mn, P, and the like are added to the base. This method is disclosed in, for example, ~~Patent Document 1.~~ Japanese Unexamined Patent Application Publication No. 56-139654.

Kindly replace [paragraph 0007] with the following:

Japanese Unexamined Patent Application Publication No. 56-139654 ~~Patent Document 1~~ discloses a technique for a high-strength cold rolled steel sheet having excellent formability, anti-aging properties, a tensile strength at the level of 35 to 45 kgf/mm^2 (level of 340 to 440 MPa), and the composition: C: 0.002 to 0.015%, Nb: C% × 3 to C% × 8 + 0.020%, Si: 1.2% or less, Mn: 0.04 to 0.8%, and P: 0.03 to 0.10%. Specifically, this document discloses that a anti-aging high-strength cold-rolled steel sheet having a TS of 46 kgf/mm^2 (450 MPa) and an average r value of 1.7 can be produced by hot rolling, cold rolling, and recrystallization annealing ultra low

carbon steel used as a raw material and containing 0.008% of C, 0.54% of Si, 0.5% of Mn, 0.067% of P, and 0.043% of Nb.

Kindly replace paragraph [0010] with the following:

For example, ~~Patent Document 2 or 3~~ Japanese Examined Patent Application Publication No. 55-10650 or Japanese Unexamined Patent Application Publication No. 55-100934 discloses a technique as an attempt to improve the r value of such a dual-phase steel sheet

Kindly replace paragraph [0011] with the following:

~~Patent Document 2~~ Japanese Examined Patent Application Publication No. 55-10650 discloses a method including cold rolling, box annealing at a temperature of a discloses a method including cold rolling, box annealing at a temperature of a recrystallization temperature to an Ac_3 transformation point, heating to 700 to 800°C for forming a dual phase, and then quenching and tempering. However, this method includes quenching and tempering in continuous annealing, and thus has the problem of production cost. Also, box annealing is inferior in treatment time and efficiency to continuous annealing.

Kindly replace paragraph [0012] with the following:

The technique of ~~Patent Document 3~~ Japanese Unexamined Patent Application Publication No. 55-100934 for achieving a high r value includes cold rolling, box annealing at a temperature in a ferrite (α)-austenite (γ) intercritical region, and then continuous annealing. In this technique, Mn is concentrated from a α phase to a γ phase in soaking for box annealing. Then, the Mn-concentrated phase is preferentially converted to the γ phase during continuous annealing, and thereby a mixed microstructure can be obtained by cooling even at a gas jet cooling rate. However, this method requires long-term box annealing at a relatively high temperature for concentrating Mn, and also requires a large number of steps. Therefore, the

method has not only low economics from the viewpoint of production cost but also many problems with the production process, such as the adhesion of coiled steel sheets, the occurrence of a temper color, a decrease in life of a furnace inner cover, and the like.

Kindly replace paragraph [0013] with the following:

~~Patent Document 4~~ Japanese Examined Patent Application Publication No. 1-35900 discloses a process for producing a dual-phase high-strength cold-rolled steel sheet having excellent deep drawability and shape fixability, in which steel containing 0.003 to 0.03% of C, 0.2 to 1% of Si, 0.3 to 1.5% of Mn, and 0.02 to 0.2% of Ti ((effective Ti/(C+N)) atomic concentration ratio of 0.4 to 0.8) is hot-rolled, cold-rolled, and then continuously annealed by heating to a predetermined temperature and then rapidly cooling. Specifically, the document discloses that steel having a composition including, % by mass, 0.012% of C, 0.32% of Si, 0.53% of Mn, 0.03% of P, and 0.051% of Ti is cold-rolled, heated to 870°C in a α-γ intercritical region, and then cooled at an average cooling rate of 100 °C/s to produce a dual-phase cold rolled steel sheet having a r value of 1.61 and a TS of 482 MPa. However, a water quenching apparatus is required for achieving a cooling rate of as high as 100 °C/s, and a problem with surface treatment properties of a water-quenched steel sheet is actualized, thereby causing problems of production equipment and material quality.

Kindly replace paragraph [0014] with the following:

~~Patent Document 5~~ Japanese Unexamined Patent Application Publication No. 2002-226941 discloses a technique for improving the r value of a dual-phase steel sheet by optimizing the V content in relation to the C content. In this technique, C contained in steel is precipitated as a V-based carbide to minimize the amount of dissolved C before recrystallization annealing, thereby achieving a high r value. Then, the steel is heated in the α-γ intercritical region to

dissolve the V-based carbide and concentrate C in the γ phase, and then cooled to produce a martensite phase. The addition of V increases the cost because V is expensive, and VC precipitated in the hot-rolled sheet increases deformation resistance in cold rolling. Therefore, for example, in cold rolling with a reduction ratio of 70% as disclosed in an example, a load on a roll is increased to cause the problems with production, such as an increase in the danger of occurrence of a trouble and the possibility of decreasing productivity.

Kindly replace paragraph [0015] with the following:

Furthermore, ~~Patent Document 6~~ Japanese Unexamined Patent Application Publication No. 2003-64444 discloses a technique as a technique for a high-strength steel sheet having excellent deep drawability and a process for producing the same. This technique is aimed at producing a high-strength steel sheet having a predetermined C content, an average r value of 1.3 or more, and a microstructure containing at least one of bainite, martensite, and austenite in a total of 3% or more. The process for producing the steel sheet includes cold rolling with a reduction rate of 30 to 95%, annealing for forming Al and N clusters and precipitates to develop a texture and increase the r value, and then heat treatment for causing the texture to contain at least one of bainite, martensite, and austenite in a total of 3% or more. This method requires annealing for achieving a high r value after cold rolling and then heat treatment for obtaining the texture, and the annealing step basically includes box annealing and requires a long holding time of 1 hour or more, thereby causing the problem of low productivity of the process (processing time). Furthermore, the resultant texture has a relatively high second phase fraction, and thus it is difficult to stably secure an excellent strength-ductility balance.

~~Patent Document 1: Japanese Unexamined Patent Application Publication No. 56-139654~~

~~Patent Document 2: Japanese Examined Patent Application Publication No. 55-10650~~

~~Patent Document 3: Japanese Unexamined Patent Application Publication No. 55-100934~~

~~Patent Document 4: Japanese Examined Patent Application Publication No. 1-35900~~

~~Patent Document 5: Japanese Unexamined Patent Application Publication No. 2002-226941~~

~~Patent Document 1: Japanese Unexamined Patent Application Publication No. 2003-64444~~

Kindly replace paragraph [0016] with the following:

~~Disclosure of Invention~~

The conventional method for increasing strength by solid-solution strengthening, which has been conventionally investigated, requires the addition of large amounts or excessive amounts of alloy elements for increasing the strength of a (mild) steel sheet having excellent deep drawability, and thus the method has problems with the cost and process and problems with improvement in the r value.

Kindly replace paragraph [0018] with the following:

~~An object of the present invention is~~ Thus, it could be helpful to resolve the problems of the conventional methods and provide a high-strength steel sheet having a TS of 440 MPa or more, an average r value $\geq$ 1.2, and excellent deep drawability, and a production process therefor. ~~Another object of the present invention is~~ It could also be helpful to provide a high-strength steel sheet having a high average r value of 1.2 or more and excellent deep drawability while maintaining high strength, such as TS $\geq$ 500 MPa or TS $\geq$ 590 MPa, and a production process therefor.

Kindly replace paragraph [0019] with the following:

Summary

~~As a result of intensive research for solving the above-described problems, the production of~~ We succeeded in producing a high-strength steel sheet having an average r value of 1.2 or more and excellent deep drawability ~~was succeeded~~ by controlling the Nb content in relation to the C content within a C content range of 0.010 to 0.050% by mass without using special or excessive alloy elements and equipment, the steel sheet having a steel microstructure containing a ferrite phase and a martensite phase.

Kindly replace paragraph [0020] with the following:

In other words, ~~the gist of the present invention lies in the following~~ we provide:

(1) A high-strength steel sheet having excellent deep drawability, an average r value of 1.2 or more, and a composition containing, by % by mass:

C: 0.010 to 0.050%;

Si: 1.0% or less;

Mn: 1.0 to 3.0%;

P: 0.005 to 0.1%;

S: 0.01% or less;

Al: 0.005 to 0.5%;

N: 0.01% or less;

Nb: 0.01 to 0.3%; and

the balance substantially including Fe and inevitable impurities, the Nb and C contents in steel satisfying the relation, (Nb/93)/(C/12) = 0.2 to 0.7 (wherein Nb and C represents the contents (%

by mass) of the respective elements), and the steel microstructure containing a ferrite phase and a martensite phase at area ratios of 50% or more and 1% or more, respectively.

(2) The high-strength steel sheet having excellent deep drawability described above in (1), the steel sheet satisfying the following relation between the normalized X-ray integrated intensity ratios of (222) plane, (200) plane, (110) plane, and (310) plane parallel to the sheet plane at a 1/4 thickness of the steel sheet:

$P_{(222)}/\{P_{(200)} + P_{(110)} + P_{(310)}\} \geq 1.5$ (wherein $P_{(222)}$, $P_{(200)}$, $P_{(110)}$, and $P_{(310)}$ are the normalized X-ray integrated intensity ratios of the (222) plane, (200) plane, (110) plane, and (310) plane, respectively, parallel to the sheet plane at a 1/4 thickness of the steel sheet).

(3) The high-strength steel sheet having excellent deep drawability described above in (1) or (2), the steel sheet further containing at least one of Mo, Cr, Cu, and Ni in a total of 0.5% by mass or less in addition to the above-described composition.

(4) The high-strength steel sheet having excellent deep drawability described above in (1), (2), or (3), the steel sheet further containing 0.1% by mass or less of Ti in addition to the above-described composition, the contents of Ti, S, and N satisfying the following relation:

$(Ti/48)/\{(S/32) + (N/14)\} \leq 2.0$ (wherein Ti, S, and N represent the contents (% by mass) of the respective elements).

(5) The high-strength steel sheet having excellent deep drawability described above in any one of (1) to (4), the steel having a plated layer on a surface thereof.

(6) A process for producing a high-strength steel sheet having excellent deep drawability, the process including a hot rolling step of finish-rolling a steel slab by hot rolling at a finisher delivery temperature of 800°C or more and coiling the hot-rolled sheet at a coiling temperature of 400 to 720°C, a cold-rolling step of cold-rolling the hot-rolled sheet to form a cold-rolled

sheet, and a cold-rolled sheet annealing step of annealing the cold-rolled sheet at an annealing temperature of 800 to 950°C and then cooling the annealed sheet in a temperature range from the annealing temperature to 500°C at an average cooling rate of 5 °C/s or more, the steel slab having a composition containing, by % by mass:

C: 0.010 to 0.050%;

Si: 1.0% or less;

Mn: 1.0 to 3.0%;

P: 0.005 to 0.1%;

S: 0.01% or less;

Al: 0.005 to 0.5%;

N: 0.01% or less;

Nb: 0.01 to 0.3%; and

the Nb and C contents in steel satisfying the relation, (Nb/93)/(C/12) = 0.2 to 0.7 (wherein Nb and C represent the contents (% by mass) of the respective elements).

(7) A process for producing a high-strength steel sheet having excellent deep drawability includes a hot rolling step of hot-rolling a steel slab to form a hot-rolled sheet having an average crystal grain size of 8 μm or less, a cold-rolling step of cold-rolling the hot-rolled sheet to form a cold-rolled sheet, and a cold-rolled sheet annealing step of annealing the cold-rolled sheet at an annealing temperature of 800 to 950°C and then cooling the annealed sheet in a temperature range from the annealing temperature to 500°C at an average cooling rate of 5 °C/s or more, the steel slab having a composition containing, by % by mass:

C: 0.010 to 0.050%;

Si: 1.0% or less;

Mn: 1.0 to 3.0%;

P: 0.005 to 0.1%;

S: 0.01% or less;

Al: 0.005 to 0.5%;

N: 0.01% or less;

Nb: 0.01 to 0.3%; and

the Nb and C contents in steel satisfying the relation, (Nb/93)/(C/12) = 0.2 to 0.7 (wherein Nb and C represent the contents (% by mass) of the respective elements).

(8) The process for producing the high-strength steel sheet having excellent deep drawability described above in (6) or (7), in which the steel slab further contains at least one of Mo, Cr, Cu, and Ni at a total of 0.5% by mass or less in addition to the above-described composition.

(9) The process for producing the high-strength steel sheet having excellent deep drawability described above in (6), (7), or (8), in which the steel slab further contains 0.1% by mass or less of Ti in addition to the above-described composition, the contents of Ti, S, and N in steel satisfying the following relation:

$(Ti/48)/\{(S/32) + (N/14)\} \leq 2.0$ (wherein Ti, S, and N represent the contents (% by mass) of the respective elements).

(10) The process for producing the high-strength steel sheet having excellent deep drawability described above in any one of (6) to (9), the process further including a plating step of forming a plated layer on a surface of the steel sheet after the cold-rolled sheet annealing step.

Kindly replace paragraph [0021] with the following:

~~In the present invention, a~~ A texture suitable for deep drawability is developed under a condition in which unlike in conventional ultra low carbon IF steel, the amount of dissolved C adversely affecting deep drawability is not excessively decreased in a rage of 0.010 to 0.050% by mass, leaving an amount of dissolved C necessary for forming a martensite phase, thereby securing an average r value of 1.2 or more and high drawability and forming a dual-phase microstructure of steel having a ferrite phase and a second phase including a martensite phase. As a result, a high strength TS of 440 MPa or more, preferably 500 MPa or more, and more preferably 590 MPa or more can be achieved.

Kindly replace paragraph [0022] with the following:

Although the reason for this is not necessarily clear, a conceivable reason is as follows:

Conventional effective means for increasing the r value of a mild steel sheet by developing a {111} recrystallized texture is to minimize the amount of dissolved C before cold rolling and recrystallization or to make fine the microstructure of a hot-rolled sheet. On the other hand, the above-described DP steel sheet requires dissolved C for forming a martensite phase and thus has a low r value because a recrystallized texture as a main phase is not developed. However, ~~in the present invention, it has been newly~~ we found that there is a very preferred component region capable of both developing a {111} recrystallized texture of a ferrite phase serving as a matrix phase and forming a martensite phase. In other words, it has been newly found that by controlling the C content to 0.010 to 0.050% by mass which is lower than that of a conventional DP steel sheet (low carbon steel level) and higher than that of ultra low carbon steel, and appropriately adding Nb according to the C content, development of a texture suitable

for deep drawability, such as a {111} recrystallized texture, formation of a martensite phase can be both achieved.

Kindly replace paragraph [0024] with the following:

~~According to the present invention, in particular, the~~ The hot-rolling finish temperature is controlled in an appropriate range directly above the Ar_3 transformation point to make fine the hot-rolled sheet microstructure, and the coiling temperature after hot rolling is also appropriately set to precipitate NbC in the hot-rolled sheet and decrease the amount of dissolved C before cold rolling and before recrystallization.

Kindly replace paragraph [0026] with the following:

It has been thought that the presence of such C inhibits the development of a {111} recrystallized texture. However, ~~in the present invention,~~ a higher r value can be achieved under a condition in which C is not completely precipitated and fixed as NbC, leaving dissolved C necessary for forming a martensite phase.

Kindly replace paragraph [0027] with the following:

Although the reason for this is not clear, a conceivable reason is that ~~within the scope of the present invention,~~ the positive factor of the presence of solute C for refinement of the hot-rolled sheet microstructure is larger than the negative factor of the presence of solute C for the formation of a {111} recrystallized texture. The precipitation of NbC has not only the effect of precipitating and fixing solute C possibly inhibiting the formation of the {111} recrystallized texture but also the effect of suppressing the precipitation of cementite. In particular, coarse cementite on a grain boundary decreases the r value, but Nb possibly has the effect of inhibiting the precipitation of coarse cementite at a grain boundary because of the higher grain boundary diffusion rate than the transgranular diffusion rate. Furthermore, during cold rolling, a matrix is

hardened due to the presence of the finely precipitated NbC within a grain (matrix), and thus strain is easily accumulated near a grain boundary relatively softer than the matrix. Therefore, the effect of accelerating the occurrence of a {111} recrystallized grain from a grain boundary is estimated. In particular, it is supposed that the effect of the precipitation of NbC in the matrix is exhibited within the appropriate C content range (0.010 to 0.050% by mass) ~~of the present invention~~, not effective at the C content of conventional ultra low carbon steel. The technical idea ~~of the present invention~~ is based on the finding of the appropriate C content range.

Kindly replace paragraph [0029] with the following:

According to the production process ~~of the present invention~~, a degassing step for making ultra low carbon steel in the steel making process is not required, and excessive alloy elements need not be added for utilizing solid-solution strengthening, as compared with conventional processes. Therefore, the production process is advantageous in cost. Furthermore, a special element which increases the alloy cost and rolling load, such as V, need not be added.

Kindly replace paragraph [0031] with the following:

Fig. 2(a) is an optical microphotograph of a hot-rolled sheet immersed in a nital solution to corrode the surface thereof in a comparative example not satisfying the proper range ~~of the present invention.~~

Kindly replace paragraph [0032] with the following:

Fig. 2(b) is an optical microphotograph of a hot-rolled sheet immersed in a nital solution to corrode the surface thereof in a comparative example not satisfying the proper range ~~of the present invention~~.

Kindly replace paragraph [0033] with the following:

Fig. 3(a) is an optical microphotograph of a hot-rolled sheet immersed in a nital solution to corrode the surface thereof in an example satisfying the proper range ~~of the present invention~~.

Kindly replace paragraph [0034] with the following:

Fig. 3(b) is an optical microphotograph of a hot-rolled sheet immersed in a nital solution to corrode the surface thereof in an example satisfying the proper range ~~of the present invention~~.

Kindly replace paragraph [0035] with the following:

~~Best Mode for Carrying Out the Invention~~ Detailed Description

~~The present invention will be described in detail below.~~

Kindly replace paragraph [0037] with the following:

First the reasons for limiting the composition of a high-strength steel sheet ~~of the present invention~~ will be described.

Kindly replace paragraph [0047] with the following:

Nb: 0.01 to 0.3% and (Nb/93)/(C/12) = 0.2 to 0.7

Nb is the most important element ~~in the present invention~~ and has the function to make fine the microstructure of a hot-rolled sheet and precipitate and fix C as NbC in the hot-rolled sheet. Nb is also an element contributing to an increase in the r value. From this viewpoint, 0.01% or more of Nb must be contained. On the other hand, ~~in the present invention,~~ solute C is required for forming a martensite phase in a cooling step after annealing. The excessive Nb content exceeding 0.3% inhibits the formation of the martensite phase, and thus the upper limit of the Nb content is 0.3%.

Kindly replace paragraph [0050] with the following:

The basic composition of the high-strength steel sheet ~~of the present invention~~ is as described above.

Kindly replace paragraph [0051] with the following:

~~In the present invention,~~ In ~~in~~ addition to the above composition, at least one of Mo, Cr, Cu, and Ni, which will be described below, and/or Ti may be added.

At least one of Mo, Cr, Cu, and Ni: 0.5% or less in total

Kindly replace paragraph [0055] with the following:

~~In the present invention,~~ The ~~the~~ balance, excluding the above-descried components, preferably substantially includes iron and inevitable impurities.

Kindly replace paragraph [0059] with the following:

In addition to the above-described steel composition, the high-strength steel sheet ~~of the present invention~~ must have a microstructure of steel including a ferrite phase and a martensite phase at area fractions of 50% or more and 1% or more, respectively, and an average r value of 1.2 or more.

(1) Having a microstructure of steel including a ferrite phase and a martensite phase at area fractions of 50% or more and 1% or more, respectively.

Kindly replace paragraph [0060] with the following:

In order that the high-strength steel sheet ~~of the present invention~~ has high deep drawability and a tensile strength TS of 440 MPa or more, the steel sheet must be a steel sheet having a microstructure of steel including a ferrite phase and a martensite phase at area fractions of 50% or more and 1% or more, respectively, i.e., a dual-phase steel sheet. In particular, the ferrite phase contained at an area fraction of 50% or more has a microstructure in which a texture

suitable for deep drawability is developed, and thus the average r value of 1.2 or more can be achieved. When the area fraction of the ferrite phase is decreased to less than 50%, satisfactory deep drawability is difficult to secure, and thus the press formability tends to decrease. The area fraction of the ferrite phase is preferably 70% or more. In order to utilize the advantage of the dual phase, the area fraction of the ferrite phase is preferably 99% or less.

Kindly replace paragraph [0061] with the following:

~~In the present invention, the~~ The ferrite phase includes a polygonal ferrite phase and a bainitic ferrite phase transformed from an austenite phase and having a high dislocation density.

Kindly replace paragraph [0062] with the following:

~~In the present invention, it~~ It is necessary that the martensite phase is present, and the area fraction of the martensite phase is 1% or more. When the area fraction of the martensite phase is less than 1%, it is difficult to secure TS $\geq$ 440 MPa and thus difficult to achieve a satisfactory strength-ductility balance. The area fraction of the martensite phase is preferably 3% or more.

Kindly replace paragraph [0064] with the following:

The high-strength steel sheet ~~of the present invention~~ satisfies the above-described composition and microstructure of steel and an average r value of 1.2 or more.

Kindly replace paragraph [0066] with the following:

The high-strength steel sheet ~~of the present invention~~ preferably satisfies the above-described composition, microstructure of steel, and characteristics, and also the texture thereof preferably satisfies $P_{(222)}/\{P_{(200)} + P_{(110)} + P_{(310)}\} \geq 1.5$ and more preferably $P_{(222)}/\{P_{(200)} + P_{(110)} + P_{(310)}\} \geq 2.0$ wherein $P_{(222)}$, $P_{(200)}$, $P_{(110)}$, and $P_{(310)}$ are the normalized X-ray integrated intensity ratios determined by X-ray diffraction for the (222) plane, (200) plane, (110) plane, and (310) plane, respectively, parallel to the sheet plane at a 1/4 thickness of the steel sheet.

Kindly replace paragraph [0067] with the following:

Fig. 1 is a graph which plots the calculated r values and $P_{(222)}/\{P_{(200)} + P_{(110)} + P_{(310)}\}$ values of various steel sheets ~~of the present invention~~ and steel sheets of comparative examples.

Kindly replace paragraph [0069] with the following:

As a result of intensive research on a correlation between the r value and texture of the steel sheet ~~of the present invention~~, it has been found that like the {100} and {110} planes, a (310) plane texture decreases the r value to a low extent, and thus a decrease in the (310) plane contributes to an increase in the r value, but details have not been clear. Although details are not clear, it is thought that an increase in the reduction ratio of hot rolling in an unrecrystallized γ region due to addition of Nb, the precipitation of fine NbC, and the presence of C not precipitated and fixed as NbC contribute to a decrease in the (310) plane.

Kindly replace paragraph [0072] with the following:

The high-strength steel sheet ~~of the present invention~~ may be a cold-rolled steel sheet or a steel sheet having a plated layer formed by surface treatment such as electroplating or hot-dip galvanization or galvannealed layer, i.e., a plated steel sheet. Examples of the plated layer include plated layers conventionally formed on steel sheet surfaces, such as plated layers formed by pure zinc plating, zinc alloy plating using alloy elements including zinc as a main component, pure Al plating, and Al alloy plating using alloy elements including Al as a main component.

Kindly replace paragraph [0073] with the following:

Next, the preferred process for producing the high-strength steel sheet ~~of the present invention~~ will be described.

Kindly replace paragraph [0074] with the following:

Since the composition of a steel slab used in the production process ~~of the present invention~~ is the same as the composition of the above-described steel sheet, the description of the reasons for limiting the steel slab is omitted.

Kindly replace paragraph [0075] with the following:

The high-strength steel sheet ~~of the present invention~~ can be produced by a hot rolling step of hot-rolling the steel slab used as a raw material and having a composition within the above-described ranges to form a hot-rolled sheet, a cold-rolling step of cold-rolling the hot-rolled sheet to form a cold-rolled sheet, and a cold-rolled sheet annealing step of recrystallizing the cold-rolled sheet and forming a dual phase.

Kindly replace paragraph [0076] with the following:

~~In the present invention, first,~~ First, the steel slab is finish-rolled by hot rolling at a finisher delivery temperature of 800°C or more, and then coiled at a coiling temperature of 400 to 720°C to form a hot-rolled sheet (hot rolling step).

Kindly replace paragraph [0077] with the following:

The steel slab used in the process ~~of the present invention~~ is preferably produced by a continuous casting method, for preventing micro segregation of the components. However, the steel slab may be produced by an ingot-making method or a thin slab casting method. After the steel slab is produced, the steel slab is cooled to room temperature, and then again heated according to a conventional process. However, an energy saving process including hot direct rolling or direct hot charge rolling may be used without any problem, in which the hot steel slab delivered casting machine is rolled directly at the hot strip mill, or the hot steel slab is charged in

a heating furnace without being cooled at room temperature and then after slight heat retaining hot-rolled.

Kindly replace paragraph [0083] with the following:

The above-described hot-rolling step is capable of producing the hot-rolled steel sheet having an average crystal grain size of 8 μm or less. Namely, the high-strength steel sheet ~~of the present invention~~ can be produced by a cold rolling step of cold-rolling the hot-rolled sheet used as a raw material and having a composition in the above-described ranges and an average crystal grain size of 8 μm or less, and a cold-rolled sheet annealing step of recrystallizing the cold-rolled sheet and forming the dual phase.

Kindly replace paragraph [0086] with the following:

Fig. 2(a) is the microphotograph of the hot-rolled sheet containing 0.033% of C and no Nb and having an average crystal grain size of 8.9 μm, a steel sheet produced by cold rolling and annealing the hot-rolled sheet having an average r value of 0.9. Fig. 2(b) is the microphotograph of the hot-rolled sheet containing 0.035% of C and 0.015% of Nb ((Nb/93)/(C/12) = 0.06) and having an average crystal grain size of 5.9 μm, a steel sheet produced by cold rolling and annealing the hot-rolled sheet having an average r value of 1.0. Fig. 3(a) is the microphotograph of the hot-rolled sheet containing 0.035% of C and 0.083% of Nb ((Nb/93)/(C/12) = 0.31) and having an average crystal grain size of 5.6 μm, a steel sheet produced by cold rolling and annealing the hot-rolled sheet having an average r value of 1.3. Fig. 3(b) is the microphotograph of the hot-rolled sheet containing 0.035% of C and 0.072% of Nb ((Nb/93)/(C/12) = 0.27) and having an average crystal grain size of 2.8 μm, a steel sheet produced by cold rolling and annealing the hot-rolled sheet having an average r value of 1.5. Figs. 3(a) and 3(b) show the hot-

rolled steel sheets having compositions ~~of the present invention~~. Details of the production conditions and the like are shown in Tables 1 and 2 below.

Kindly replace paragraph [0087] with the following:

Fig. 2(a) shows the hot-rolled steel sheet not containing Nb out of the composition range of steel ~~of the present invention~~ and having an average crystal grain size of 8 μm or more, thereby showing a low r value. Fig. 2(b) shows the hot-rolled steel sheet containing Nb and thus having a fine microstructure, and also having a Nb/C ratio out of the range ~~of the present invention~~, thereby exhibiting no effect and showing a low r value. Figs. 3(a) and 3(b) show the steel sheets having a fine microstructure ~~according to the present invention~~, thereby showing a higher r value.

Kindly replace paragraph [0089] with the following:

~~In the present invention,~~ A ~~a~~ crystal grain size was measured using the lines (1) and (2) as grain boundaries.

Kindly replace paragraph [0090] with the following:

With respect to the crystal grain size, a grain boundary with an inclination of 15° or more is often referred to as a "large angle grain boundary", and a grain boundary with an inclination of less than 15° is often referred to as a "small angle grain boundary". The EBSP (Electron Back Scatter Diffraction Pattern) analysis of the shallow corrosion line (2) showed that the shallow corrosion line (2) was a small angle grain boundary with an inclination of less than 15°. The hot-rolled steel sheet ~~of the present invention~~ is characterized by the presence of many small angle grain boundaries with an inclination of less than 15°, i.e., many lines (2). As a result of measurement of the grain size using both the lines (1) and (2) as grain boundaries, it was found that with an average crystal grain size of over 8 μm, the effect of increasing the r value of the

high-strength steel sheet ~~of the present invention~~ is not exhibited, while with an average crystal grain size of as small as 8 μm or less, the average r value is 1.2 or more, and the effect of increasing the r value is exhibited. Therefore, the average crystal grain size of the hot-rolled sheet is preferably 8 μm or less.

Kindly replace paragraph [0091] with the following:

As a result of EBSP analysis of the microstructure of steel ~~of the present invention~~, it was confirmed that measurement of a crystal grain size using the lines (1) and (2) as grain boundaries corresponds to measurement of a grain size assuming that crystal grain boundaries with an inclination of 5° or more are grain boundaries.

Kindly replace [0094] with the following:

~~In the present invention,~~ The ~~the~~ average section length for the average grain size was determined by imaging a microscopic structure of a sheet section parallel to the rolling direction with an optical microscope and a cutting method according to JIS G 0552. Namely, the number of the ferrite crystal grains which were cut with a predetermined segment length in the rolling direction and the direction perpendicular to the rolling direction according to JIS G 0552 was measured, the segment length was divided by the number of the ferrite crystal grains cut with the segment length to determine a section length in each direction, and an average (arithmetic mean) of the section lengths was calculated as the average section length l (μm) of the crystal grains.

Kindly replace [0095] with the following:

Furthermore, in the steel ~~of the present invention~~, 15% or more of the total C content is preferably precipitated and fixed as NbC in the hot rolling step. In other words, in the hot rolling step, the ratio of C precipitated and fixed as NbC in steel is preferably 15% or more relative to the total C content.

Kindly replace paragraph [0100] with the following:

As described above, in order to increase the r value, it is effective to decrease the amount of solute C before cold rolling and recrystallization, and the presence of precipitated NbC promotes an increase in the r value. ~~In the present invention,~~ When ~~when~~ the content of precipitated and fixed C is 15% or more relative to the total C content in steel, the effect is exhibited. When the upper limit of the ratio of precipitated and fixed C relative to the total C content satisfies the condition that the Nb content is less than the upper limit of the proper Nb range, (Nb/93)/(C/12) = 0.7, a higher r value and the formation of the martensite phase after annealing are both satisfied without any problem.

Kindly replace paragraph [0104] with the following:

The annealing is preferably continuous annealing to be performed in a continuous annealing line or a continuous hot-dip galvanization line, for securing the cooling rate ~~required in the present invention~~, and the annealing must be performed in a temperature range from 800°C to 950°C. ~~In the present invention,~~ The ~~the~~ maximum attained temperature of annealing, i.e., the annealing temperature, is set to 800°C or more, thereby attaining at least a temperature at which a α-γ intercritical region, i.e., a microstructure including a ferrite phase and a martensite phase, can be obtained after cooling, and at least the recrystallization temperature. When the annealing temperature is lower than 800°C, the martensite phase cannot be sufficiently formed after cooling, or recrystallization is not completed to fail to form a texture of a ferrite phase, thereby failing to increase the r value. Therefore, the annealing temperature is 800°C or more. On the other hand, when the annealing temperature exceeds 950°C, recrystallized grains are significantly coarsened, thereby significantly degrading the characteristics. Therefore, the annealing temperature is 950°C or less.

Kindly replace paragraph [0105] with the following:

Furthermore, when the heating rate of the steel sheet ~~of the present invention~~ during the annealing, particularly the rate of heating from 300°C to 700°C, is less than 1 °C/s, strain energy tends to be released due to recovery before recrystallization, and consequently the driving force of recrystallization is decreased. Therefore, the average heating rate from 300°C to 700°C is preferably 1 °C/s or more. The upper limit of the heating rate need not be particularly specified, but, with current equipment, the upper limit of the average heating rate from 300°C to 700°C is about 50 °C/s. Therefore, the temperature is preferably increased from the 700°C to the annealing temperature at a heating rate of 0.1 °C/s or more from the viewpoint of formation of the recrystallized texture. However, when the temperature is increased from 700°C to the annealing soaking temperature (annealing ultimate temperature) at 20 °C/s or more, transformation from an unrecrystallized portion or transformation of the unrecrystallized portion itself easily proceeds to cause a disadvantage in forming the texture. Thus, the heating rate is preferably 20 °C/s or less.

Kindly replace paragraph [0107] with the following:

~~In the present invention,~~ The ~~the~~ presence of a second phase including a martensite phase is essential, and thus the average rate of cooling to 500°C must be the critical cooling rate or more. This can be satisfied by an average cooling rate of 5 °C/s or more. Cooling to lower than 500°C is not particularly limited, but the cooling is preferably performed continuously or preferably up to 300°C at an average cooling rate of 5 °C/s or more. When overaging is performed, the average cooling rate is preferably 5 °C/s or more up to the overaging temperature.

Kindly replace paragraph [0114] with the following:

EXAMPLES

Examples ~~of the present invention~~ will be described below.

Kindly replace paragraph [0127] with the following:

The measurement results shown in Table 2 indicate that in all examples ~~of the present invention~~, TS is 440 MPa or more, the average r values are 1.2 or more, and thus deep drawability is excellent. On the other hand, the steel sheets of comparative examples produced under conditions out of ~~the~~ our range ~~of the present invention~~ have low strength or r values of less than 1.2, and thus exhibit low deep drawability.

Kindly replace paragraph [0128] with the following:

Industrial Applicability

~~According to the present invention,~~ A ~~a~~ high-strength steel sheet having an average r value of 1.2 or more and excellent drawability can be stably produced at low cost even when strength TS is 440 MPa or more or when the strength TS is 500 MPa or 590 MPa or more. Therefore, an industrially significant effect can be exhibited. For example, when a high-strength steel sheet ~~of the present invention~~ is applied to an automobile part, the strength of a portion, which has have difficulty in press forming so far, can be increased, thereby causing the effect of sufficiently contributing to safety at the time of crash and weight lightening of vehicles bodies. The steel sheet can also be applied household electric appliances and pipe materials as well as automobile parts.